AN AUTOCOLLIMATING MOUNTING FOR A CONCAVE GRATING[1]

THE usual form of mounting for a concave grating is cumbersome and has the objection that either the receiving apparatus or the source must be movable. This may be avoided by employing the method of autocollimation, using that part of the light which after being diffracted is returned toward the slit. If therefore the slit is on Rowland's circle, the spectrum will be formed on the same circle and one point of it will coincide with the slit (Fig. 1). The wave-length of the light which

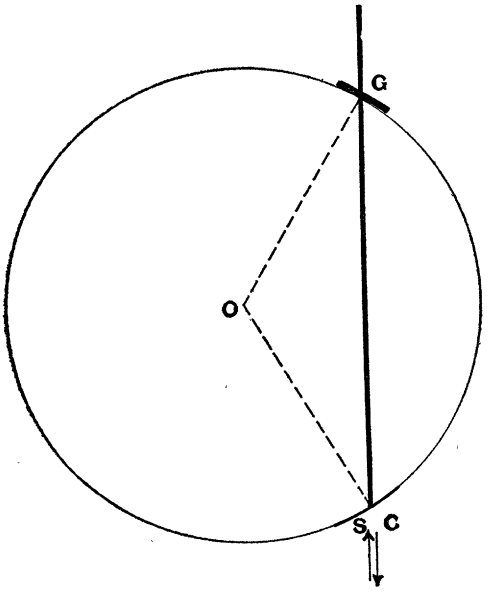

FIG. 1

is returned to the slit is given by the formula

$$\lambda = (2e/m) \sin \phi,$$

where e is the distance between consecutive rulings, ϕ the angle made by the light with the grating-normal, and m the order of the spectrum. It follows that at a given angle the order is twice that which is produced at the center of curvature.[2]

[1] Abstract of a paper read before the American Philosophical Society, April 20, 1912.

[2] The application of autocollimation to the concave grating was first described by A. Eagle, *Astrophys. Jour.*, 31, p. 120, 1910.

In this method, since the focal length changes in passing through the spectra, not only the inclination of the grating, but also its distance from the slit, must be altered. In addition the focal plane, which coincides with the arc of Rowland's circle, is inclined to the direction of the light by the same angle as the grating, and therefore the inclination of the camera must be changed to correspond with that of the grating. See Fig. 1, where G is the grating, S the slit, and the arc at C represents the position of the photographic plate in the camera.

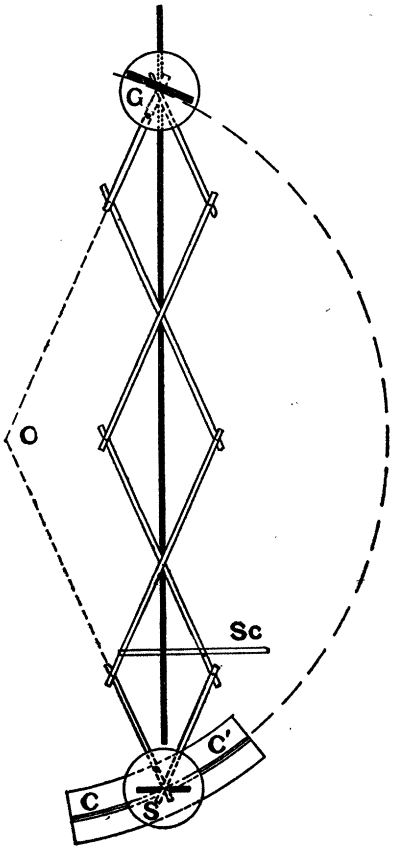

FIG. 2

In the instrument here described these adjustments are automatically made in the following manner. The grating is carried on a platform which slides along a horizontal track GS (Fig. 2) and is also capable of rotation

about a vertical axis through its center. At one end of the track is a fixed vertical axis, carrying a platform S for the slit and another CC' for the camera, both capable of rotation. The two axes are joined by a system of link bars of the "lazy-tongs" type, the total length of which, when fully extended, is equal to ρ, the radius of the grating. It is obvious that when the inclination of the bars to the track is ϕ, the distance GS will be $\rho \cos \phi$. If then the first and last bars of the linkage on one side are connected to the camera and grating so as to be parallel respectively to their normals, the inclination of both camera and grating will be correct however the distance GS is altered. Since either side may be used, all the grating spectra become available.

The linkage is supported at its intersections by blocks which slide along the track. The grating slider is moved by a rod or screw running to the end of the track near the slit, the only function of the linkage being to produce the necessary rotation. There is therefore no great stress on the axes tending to bend them. The grating and slit are provided with the usual adjustments and also may be shifted on their platforms until their centers fall exactly in the axes of rotation. The camera is mounted on its platform on either side of the slit at C or C' or preferably just above it, and may be adjusted so as to bring the plate into coincidence with the focal circle. For visual observation the plateholder may be replaced by an eyepiece. The slit is made double so that light may be sent through one part and returned through the other. The apparatus is thus available for a threefold use, as a spectrograph, as an observing spectroscope, and as a monochromator.

The diagonal of any parallelogram of the linkage perpendicular to the track is proportional to sin ϕ, and therefore to the wave-length. A scale of equal parts placed across any part of the linkage perpendicular to the track, as Sc (Fig. 2), will, therefore, give an approximate measure of the wave-length. A more open scale may be placed on the track, but this will not be one of equal parts.

As everything is supported upon one track, the apparatus may be made quite rigid, and at the same time, with the smaller gratings at least, portable. It will take up much less space than the other mountings. It is also more convenient, as everything is in reach at the same time from the end of the track—source, slit, camera and handle for controlling the position of the grating. There is but one track to make true, and the other adjustments are no more difficult, and in some cases much easier, than in the Rowland mounting. A very desirable feature is that the slit, grating and camera may be connected by a light-proof bellows or other enclosure, so that the instrument may be used in an undarkened room. This bellows may be supported partly upon the blocks which carry the linkage.

The great compactness of the mounting makes it available for use in astronomical spectroscopy. The instrument may be mounted upon a telescope in the prolongation of its axis so that the slit lies in the focal plane of the objective. (In the case of a star image the slit could be dispensed with, and the astigmatism of the grating would produce a spectrum of finite width.) A more rigid and more convenient arrangement would be to mount the guides for the grating upon the tube of the telescope. The light could be brought to a focus by the objective at the side of the field nearest the slit and thrown upon the slit by totally reflecting prisms.

The definition of the spectrum is somewhat greater than with the usual mounting, when spectra of the same order are compared. Moreover twice as many orders on each side may be observed. The principal disadvantages are that the scale of the spectra is not constant, so that the spectra are not normal. The deviations, however, are quite small and may be accurately allowed for. Another objection is the inclination of the plate, which requires special care in its register. These objections, which are shared by prism spectrographs, are much less serious when comparison spectra are used on the same plate.

Horace Clark Richards
Randal Morgan Laboratory of Physics,
University of Pennsylvania